EPOXY ACRYLIC COATING COMPOSITION MODIFIED WITH A TRIALKOXY SILANE

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23 Claims

ABSTRACT OF THE DISCLOSURE

Sealer compositions comprising binders dissolved in organic solvents wherein the binder comprises:

(a) 50–99 parts of a high molecular weight epoxy resin;
(b) 0–50 parts of an acrylic polymer; and
(c) 1–25 parts of a trialkoxy-silane having the structural formula,

\[ R_1 \]
\[ R_2 \]
\[ R_3 \]
\[ Si-O-R_4 \]

wherein \( R_1 \), \( R_2 \) and \( R_3 \) are individually selected from the group of methyl, ethyl and propyl and wherein \( R_4 \) is a monovalent radical which promotes adhesion.

The sum of the binder components is 100 parts. A preferred silane is N-beta[(aminoethyl)gamma-aminoethylpropyl trimethoxysilane.

BACKGROUND OF THE INVENTION

This invention relates broadly to film-forming compositions and more particularly to sealer compositions. Although sealer compositions are well known in the prior art, previously it has been difficult or impossible to provide a sealer composition which retained its chip-resistance properties over broad temperature ranges and particularly at low temperatures of around 0° F. Chip-resistance is the ability of a finish coating to withstand impact without chipping away from the substrate. In the automotive industry, this is particularly a problem because of the chipping away of automobile finishes caused by the frequent impacts from road pebbles, etc.

SUMMARY OF THE INVENTION

According to this invention, there is provided a sealer composition which comprises a binder dissolved in an organic solvent, the binder comprising the following components:

(a) From about 50 to about 99 parts by weight of a high molecular weight epoxy resin;
(b) From 0 to about 50 parts by weight of an acrylic polymer; and
(c) From about 1 to about 25 parts by weight of a trialkoxy-silane having a structural formula,

\[ R_1 \]
\[ R_2 \]
\[ R_3 \]
\[ Si-O-R_4 \]

wherein \( R_1 \), \( R_2 \) and \( R_3 \) are individually selected from the group of methyl, ethyl and propyl, and wherein \( R_4 \) is a monovalent adhesion-promoting radical. The sum of the binder components is equal to 100 parts by weight.

A process for preparing these compositions is also provided which comprises:

(a) Combining from about 1 to about 25 parts of a trialkoxy-silane with an amount of organic solvent and either none or some amount of nonreactants, such that the concentration of trialkoxy-silane is less than about 1 part of trialkoxy-silane per 10 parts of organic solvent or per 10 parts of the sum of the organic solvent and non-reactants present;
(b) Dissolving from no parts to about 50 parts of an acrylic polymer in the organic solvent; and
(c) Dissolving from about 50 to about 99 parts of a high molecular weight epoxy resin in the organic solvent. The trialkoxy-silane has the same structural formula as is disclosed above.

One advantage of the sealer compositions of this invention is that they provide better chip resistance than the sealer compositions of the prior art and do so with a greater degree of reliability over wide temperature variations. Another advantage is that the sealer compositions of this invention provide in general stronger bonds than prior art compositions between the substrate and coating they are joining. The sealer compositions of this invention also exhibit improved corrosion resistance properties over the compositions of the prior art.

DESCRIPTION OF THE INVENTION

Trialkoxy silanes useful for this invention have the structural formula,

\[ R_1 \]
\[ R_2 \]
\[ R_3 \]
\[ Si-O-R_4 \]

\( R_1 \), \( R_2 \) and \( R_3 \) in this formula can be methyl, ethyl or propyl and can be the same or different. \( R_4 \) is a monovalent adhesion-promoting radical. One embodiment of \( R_4 \) is where \( R_4 \) has the structural formula,

\[ -(CH_2)_m-H \]

wherein \( m \) is an integer of 0 to 3 and \( R_2 \) has a structural formula selected from the group of:

\[ CH_3NH_2 \]
\[ CH_3N(CH_2OH)_2 \]
\[ CH_2-NHCH_2CH_2NH_2 \]
\[ CH_2-NHCH=NH_2 \]
\[ CH_3N(CH_2CH_2)_2 \]
\[ CH_3N(CH_2)_2 \]
\[ CH_2NH-C(CH_3)_3 \]
\[ CH_2-N=C(CH_3)_2 \]

and
$R_3$ can also be any other monovalent radical which causes the resulting trialkoxysilane to exhibit good adhesion properties between high molecular weight epoxy resins and other organic substrates.

Good sealers can be prepared using the following trialkoxysilanes: N-bis(beta-hydroxyethyl)gamma-amino propyl, gamma-amino propyl, and N-beta(aminooethyl) gamma-amino propyl.

Other examples of suitable trialkoxysilanes include:

N-beta(aminooethyl) gamma-amino propyl trimethoxysilane
N-beta(aminooethyl) gamma-amino propyl triethoxysilane
N-beta(aminooethyl) gamma-amino propyl diethoxysilane
N-beta(aminooethyl) gamma-amino propyl trimethoxysilane
N-beta(aminooethyl) gamma-amino propyl tripriproxy silane
N-beta(aminooethyl) gamma-amino propyl trimethoxy silane
N-bis(beta-hydroxyetheryl) gamma-amino propyl tri ethoxysilane
N-bis(beta-hydroxyetheryl) gamma-amino propyl trimethoxy silane
Gamma-amino propyl triethoxysilane
Gamma-amino propyl trimethoxysilane

The preferred trialkoxysilane for this invention is N-beta(aminooethyl) gamma-amino propyl trimethoxysilane which has the structural formula:

\[
\text{CH}_3\text{O}-\text{Si}-\text{O}-\text{CH}_3
\]

This is preferred because it exhibits an unusually high degree of adhesion to metals and organic substrates such as automotive sheet metal and high baked primers.

N-beta(aminooethyl) gamma-amino propyl trimethoxysilane is commercially available from Union Carbide Corp., Silicons Division under the trade name A-1120 Silane.

Epoxy useful for this invention have, in general, high molecular weights ranging from about 20,000 to about 200,000. Because of the high molecular weight and linearity of these epoxy resins, they are very low in epoxide functionality.

The preferred epoxy resin is epichlorohydrin-bisphenol A polymer.

A more detailed description of high molecular weight epoxy resins suitable for use with this invention can be found in the pending application, Rohrbacher, U.S. Ser. No. 650,197, filed June 30, 1967, which is hereby expressly incorporated by reference.

Acrylic polymers suitable for use in the sealer compositions of this invention include both nonadhesion-promoting polymers and adhesion-promoting polymers.

Examples of suitable nonadhesion-promoting acrylic and nonacrylic polymers include polymers prepared from the following monomers: esters of acrylic acid or of methacrylic acid with alcohols having from 1 to 18 carbon atoms such as methyl acrylate or methacrylate, ethyl acrylate or methacrylate, propyl acrylate or methacrylate, isopropyl acrylate or methacrylate, the various butyl acrylates or methacrylates, cyclohexyl acrylate or meth-
EXAMPLE IA

Mill base

Ethylene glycol monomethyl ether 29.15
95/5 copolymer of methyl methacrylate and 3 - (2-methacryloxyethyl)-2, 2-spirocyclohexyl
oxazoline: 40% solids in 3/1 toluene/acetone 21.56
Pigments 49.29
Aluminum silicate 24.09
Titanium dioxide 24.25
Carbon black 0.95

Total 100.00

The above formulation is ground in a sand mill to disperse the pigment in the organic binder and is let down to a finished product in mix tank equipment as follows:

Mill base 7.13
95/3 copolymer of methyl methacrylate and 3 - (2-methacryloxyethyl)-2, 2-spirocyclohexyl
oxazoline: 40% solids in 3/1 toluene/acetone 4.61
Acetone 10.21
N - beta(aminooethyl)gamma - aminopropyltrimethoxy silane 2.76
Ethylene glycol monomethyl ether 10.20
Toluene 6.07
2000 1 - molecular weight polymer of epichlorohydrin and bisphenol A: 36% solids in methyl ethyl ketone 29.43
Toluene 5.31

Total 100.00

1 Add mix 1/2 hour.
2 Add slowly with mixing - mix 1/2 hour.
3 Add mix until uniform.
4 Add slowly with mixing - mix until uniform.
5 Add with mixing - mix 1 hour.

The example sealer composition is reduced 100% by volume with a 30/30/35/5 blend of acetone/toluene/ethylene glycol monomethyl ether ethyl acetate/ethylene glycol monomethyl ether.

It is then sprayed with pressure or suction type spray gun equipment over baked automotive sheet metal primer. This primer being an alkyl based system modified with low molecular weight epoxy resin and/or nitrogen cross-linking resin, and having a pigment volume concentration of 15 to 25%. Said primer being applied on steel by dipping or flowing to a dry film thickness of 0.1 to 1.2 mls and baked in the order of 15 to 45 minutes at 350° F. to 425° F. The example sealer is applied to a dry film thickness of 0.1 to 0.5 mil. An automotive acrylic lacquer topcoat is then sprayed applied directly over the unbaked sealer. The lacquer topcoat is applied to a dry film thickness of 2.0 to 3.0 mls and baked for 20 to 30 minutes at 275° F. to 300° F.

Test panels were prepared in the above manner and compared to:

1. A conventional acrylic based sealer; and
2. A sealer identical to the example sealer except that it contains no N-beta(aminooethyl)gamma-aminopropyltrimethoxy silane.

The test panels were then prepared under the following substrate conditions:

Substrates

Condition 1 - Primer A (alkyl based epoxy modified) dipped and baked under laboratory conditions;
Condition 2 - Primer B (alkyl based epoxy and nitrogen resin modified) dipped and baked under laboratory conditions;
Condition 3 - Primer A - primer panel is prepared in a commercially operating flow coater and oven;
Condition 4 - Primer A - primer panel is prepared in a second commercial installation;
Condition 5 - Primer B - primer panel is prepared in a third commercial installation;
Condition 6 - Primer B - primer panel is prepared in a fourth commercial installation; and
Condition 7 - Sanded auto body steel.

The panels are tested at 0° F. using the Gravelometer Chip Test described below. The results are:

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Conventional Sealer</th>
<th>Trialkoxy Silane</th>
<th>Example Sealer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

TEST PROCEDURE FOR 0° F. GRAVELOMETER CHIP TEST

The test is conducted in a 0° F. normal atmosphere. The gravelometer consists of a device to hold a 4 in. x 12 in. test panel. A 2 in. horizontal air line fitted with a valve capable of supplying compressed air at least 75 p.s.i. when the valve is wide open. The opened end of the air line is 8 in. from the test panel and pointed directly at it. The air line is fitted with a vertical 2 in. pipe 8 in. behind its opened end. The vertical pipe is 18 in. high with the upper end flared and fitted with a plug to accept 1 pint of gravel ½ in. to ⅝ in. in size.

To test the chip resistance of a system a 4 in. x 12 in. test panel is prepared. It is allowed to cool to 0° F. for a minimum of 2 hours. It is then placed in the holding device and the air valve is open to a dynamic pressure of 75 p.s.i. Then the stopper is pulled from the flared end of the vertical pipe allowing 1 pint of gravel to fall into the moving air stream. As the gravel falls into the air stream it is projected at high velocity into the test panel. The following rating system is used to describe the result of the chip test:

0 - Total failure; complete removal of the organic film.
5 - Minimum commercial acceptability, many chips, maximum size ¼ in.
6 - Many chips, maximum size ½ in.
7 - Moderate number of chips, maximum size ½ in.
9 - Few chips.
10 - Topcoat deformation only.

EXAMPLE IB

Similar results were obtained by following the procedure in Example IA except that only 19 part of N-beta(aminooethyl)gamma-aminopropyltrimethoxy silane was used instead of 0.76 part.

EXAMPLE IC

Similar results were obtained by following the procedure in Example IA except that 1.52 parts of N-beta(aminooethyl)gamma-aminopropyltrimethoxy silane was used instead of 0.76 part.

EXAMPLE II

A sealer was prepared as in Example IA except that the 95/5 copolymer of methyl methacrylate and 3 - (2-methacryloxyethyl)-2, 2-spirocyclohexyl oxazolidine was replaced with a methyl methacrylate polymer. This example sealer yields results similar to those in Example IA. However in this case if the sealer does not contain N-beta(aminooethyl)gamma-aminopropyltrimethoxy it exhibits total failure in a 0° F. Gravelometer Chip Test.
EXAMPLE III

A sealer was prepared as in Example IA using N-beta (aminoethyl)gamma-aminopropyltriethoxysilane in place of N - beta (aminoethyl)gamma-aminopropyl-trimethoxysilane. Similar results were obtained.

EXAMPLE IV

A clear sealer was prepared in the following manner:

<table>
<thead>
<tr>
<th>Parts</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toluene</td>
<td>8.88</td>
<td>8.27</td>
<td>16.38</td>
<td>38.70</td>
<td>100.00</td>
</tr>
<tr>
<td>Acetone</td>
<td>10.21</td>
<td>6.74</td>
<td>19.48</td>
<td>38.70</td>
<td>100.00</td>
</tr>
<tr>
<td>N - beta (aminoethyl)gamma - aminopropyltrimethoxysilane</td>
<td>9.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene glycol monoethyl ether</td>
<td>12.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200,000 molecular weight polymer of epichlorohydrin and bisphenol-A</td>
<td>36% solids in methyl ethyl ketone</td>
<td>36.28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>31.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total 100.00

This sealer was applied in film thickness of 0.1 to 0.5 mil to baked sheet metal primer and sanded steel as indicated in Example IA. It was then baked 15 minutes at 200° F. This was followed by an automotive acrylic lacquer topcoat as in Example IA. This system was tested in a 0° F. Gravelometer Chip Tester and found to have excellent chip resistance.

EXAMPLE V

A sealer composition was prepared using the mill base of Example IA as follows:

<table>
<thead>
<tr>
<th>Parts</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill base</td>
<td>10.43</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95/5 copolymer of methyl methacrylate and 3-(2-methacryloyloxyethyl)-2, 2-spirocyclohexyl oxazolidine -40% solids in 3/1 toluene/acetone</td>
<td>6.74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td>19.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethylene glycol monoethyl ether</td>
<td>16.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>8.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200,000 molecular weight polymer of epichlorohydrin and bisphenol A</td>
<td>38.70</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total 100.00

The example sealer is then reduced 200% by volume with a thinner having the composition:

<table>
<thead>
<tr>
<th>Parts</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N - beta (aminoethyl)gamma - aminopropyltrimethoxysilane</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total 100

The said reduced example sealer was applied to a baked sheet metal primer and topcoated as in Example IA. Similar chip results were obtained.

The coating compositions of this invention are useful as sealers particularly for providing adhesion between coatings such as acrylic lacquer topcoats to coatings such as alkyd resins, epoxy esters and oils which traditionally are nonadhesive to each other. These compositions are also useful for bonding topcoats or other organic films to such substrates as metal, fiberglass, rubber, glass, wood, plastics, cotton and other fabrics, and other organic substrates. These are particularly useful for bonding acrylic automotive topcoats to high baked steel metal primers. They are also useful for bonding decorative enamel finishes such as are found on household appli-
ances to metal or other organic substrates. Another use is in bonding an automotive topcoat to metals, particularly bright metals such as chrome, bright aluminum and stainless steel.

We claim:

1. A sealer composition which comprises a binder dissolved in an organic solvent, said binder comprising the following components:
   (a) from about 50 to about 99 parts by weight of a high molecular weight epoxy resin;
   (b) from 0 to about 50 parts by weight of an acrylic polymer selected from the group consisting of homopolymers of C1 to C4 acrylates, C3 to C8 methacrylates, acrylonitrile, methacrylonitrile and co-polymers containing monomeric units selected from the group consisting of hydroxy aminopropyl methacrylate, 3-(2-methacryloyloxyethyl) -2, 2 - spirocyclohexyl oxazolidine, 3-amino-3-hydroxy propyl methacrylate, diethyl aminomethyl methacrylate, amino-ethyl vinyl ether, 2-aminopropyl methacrylate, 2-aminoethyl methacrylate, 2-(1 - azirindly)ethyl methacrylate, t-buty1 aminomethyl methacrylate, dimethyl aminomethyl methacrylate, N-2-hydroxypropyl methacrylamide and N-2-hydroxyethyl methacrylamide; and
   (c) from about 1 to about 25 parts by weight of a trialkoxysilane having a structural formula,

\[ \begin{align*}
R_1 & \quad \text{siloxane bond} \quad R_2 \\
R_4 & \quad \text{alcohol group} \quad \text{alcohol group}
\end{align*} \]

wherein R1, R2 and R3 are individually selected from the group of methyl, ethyl and propyl, and wherein R4 is a monovalent adhesion-promoting radical having the following structural formula

\[ \begin{align*}
-\text{CH}_2- & \quad -\text{R}_5 \\
\text{wherein } m \text{ is } & \quad \text{an integer of 0 to 3 and wherein } R_5 \\
& \quad = -\text{CH}_2\text{NH}_2; -\text{CHN}_2(\text{CH}_2\text{OH})_2; \\
& \quad = -\text{CH}_2\text{NHCH}_2\text{CH}_2\text{NH}_2; \\
& \quad = -\text{CH}_2\text{CH\text{-NH}}_2; \\
& \quad = -\text{CHN}(_2\text{CH}_2)\text{NH}_2; \\
& \quad = -\text{CH}_2\text{NH\text{-C(\text{CH}_3)_2;}} \\
& \quad = -\text{CH}_2\text{N} \quad \text{or}
\end{align*} \]

the sum of said binder components being equal to 100 parts by weight.

2. A sealer composition of claim 1 wherein R4 is a monovalent adhesion-promoting radical selected from the group consisting of N-bis(beta-hydroxyethyl)gamma-aminopropyl, gamma-aminopropyl, and N-beta(aminomethyl)gamma-aminopropyl.

3. A sealer composition of claim 2 wherein R4 is N-beta(aminomethyl)gamma-aminopropyl.

4. A sealer composition of claim 3 wherein the (a) high molecular weight epoxy resin is epichlorohydrin-bisphenol A polymer having a molecular weight of from about 20,000 to about 200,000.

5. A sealer composition of claim 4 wherein the acrylic polymer is an adhesion-promoting copolymer containing monomeric units selected from the group of hydroxy aminopropyl methacrylate, 3-(2-methacryloyloxyethyl) -2, 2 - spirocyclohexyl oxazolidine, 3-amino-3-hydroxypropyl methacrylate, diethyl aminomethyl methacrylate, amino-
ethyl vinyl ether, 2-amino propyl methacrylate, 2-amino ethyl methacrylate, t-butyl aminoethyl methacrylate, dimethyl aminoethyl methacrylate, N-2-hydroxypropyl methacrylamide and N-2-hydroxyethyl methacrylamide.

6. A sealer composition of claim 5 wherein the acrylic polymer is a copolymer formed from about 95 parts of methyl methacrylate and about 5 parts of 3-(2-methacryloyloxyethyl)-2,3-spiroacyclocychexyl oxazolidine.

7. A sealer composition of claim 6 wherein the epichlorhydrin-bishphenol A polymer has a molecular weight of about 200,000.

8. A sealer composition of claim 7 wherein the acrylic polymer is present in an amount of about 18 parts, the high molecular weight epoxy resin is present in an amount of about 77 parts, and the trialkoxysilane is present in an amount of about 5 parts; the sum of said components being equal to 100 weight parts.

9. A sealer composition of claim 8 wherein the binder is dissolved in a combination of organic solvents which consists essentially of acetone, toluene, ethylene glycol monoethyl ether and methyl ethyl ketone.

10. A sealer composition of claim 9 wherein the binder is dissolved in a combination of organic solvents which consists essentially of acetone, toluene, ethylene glycol monoethyl ether, methyl ethyl ketone and isopropanol.

11. A sealer composition of claim 9 which contains pigmentant in an amount of up to 30% pigment volume concentration.

12. A sealer composition of claim 11 which contains pigmentant comprising about 49% titanium dioxide, about 49% aluminum silicate and about 2% carbon black; the total pigmentant being present in an amount of about 9% pigment volume concentration.

13. A metal substrate coated with the sealer composition of claim 1.

14. An alkyd resin based primer substrate coated with the composition of claim 1.

15. An epoxy ester substrate coated with the composition of claim 1.

16. A modified oil based primer substrate coated with the composition of claim 1.

17. A plastic substrate coated with the composition of claim 1.

18. A sealer composition of claim 4 wherein the acrylic polymer contains a monomer selected from the group consisting of methyl methacrylate, methyl acrylate, ethyl methacrylate, ethyl acrylate and combinations of these.

19. A sealer composition of claim 1 wherein the binder comprises:

(a) from about 75 to about 99 parts of epichlorohyrin-bishphenol A polymer having a molecular weight of about 20,000 to about 200,000; and

(b) from about 1 to about 3 parts of N-β(aminomethyl) gamma aminopropyl trimethoxy silane, the sum of components (a) and (b) being 100 weight parts.

20. A process for preparing a sealer composition of claim 1 having a binder dissolved in an organic solvent which comprises the following based on a total of 100 weight parts binder:

(a) combining from about 1 to about 25 parts of a trialkoxysilane with an amount of organic solvent and from 0 part to an amount of nonreactants such that the concentration of trialkoxysilane is less than about 1 part of trialkoxysilane per 10 parts of the sum of said organic solvent and said nonreactants, said trialkoxysilane having a structural formula,

<table>
<thead>
<tr>
<th>R₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>R₂</td>
</tr>
<tr>
<td>R₃</td>
</tr>
</tbody>
</table>

wherein R₁, R₂ and R₃ are individually selected from the group of methyl, ethyl and propyl, and wherein R₄ is a monovalent adhesion-promoting radical having the structural formula,

| CH₂═CH−R₄ |

wherein m is an integer of 0 to 3 and wherein R₅ is

- CH₃—NHCH₂CH₂NH₂
- CH₃—CH—NH₂
- CH₃—CH₃₂
- CH₃NH—C(CH₃)₃

or

<table>
<thead>
<tr>
<th>CH₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH₃</td>
</tr>
<tr>
<td>CH₃</td>
</tr>
</tbody>
</table>

followed by

(b) dissolving from 0 part to about 50 parts of an acrylic polymer selected from the group consisting of homopolymers of C₆ to C₁₄ acrylates, C₇ to C₁₄ methacrylates, acrylonitrile, methacrylonitrile and copolymers containing monomeric units selected from the group consisting of hydroxy aminopropyl methacrylic, 3-(2-methacryloyloxyethyl)-2,3-spiroacyclocychexyl oxazolidine, 3-amino-3-hydroxypropyl methacrylate, diethyl amino ethyl methacrylate, aminoethyl vinyl ether, 2-aminoethyl methacrylate, 2-aminoethyl methacrylate, 2-(1-aziridinyl)ethyl methacrylate, t-butyl amineethyl methacrylate, dimethyl amineethyl methacrylate, N-2-hydroxypropyl methacrylamide and N-2-hydroxethyl methacrylamide in the organic solvent; and

c) dissolving from about 50 to about 99 parts of a high molecular weight epoxy resin in the organic solvent.

21. A process of claim 20 wherein the trialkoxysilane is selected from the group consisting of N-bis(betahydroxyethyl)gamma aminopropyl triethoxy silane, gamma aminopropyl triethoxy silane and N-beta(aminomethyl)gamma aminopropyl trimethoxy silane.

22. A process of claim 21 wherein the high molecular weight epoxy resin is epichlorhydrin-bishphenol A polymer having a molecular weight of from about 20,000 to about 200,000.

23. A process of claim 22 wherein the concentration of trialkoxysilane is less than about 1 part of trialkoxysilane per about 20 parts of the sum of said organic solvent and said nonreactants.